Institution: University of Nottingham		
Unit of Assessment: 3 (Allied Health Professions, Dentistry, Nursing and Pharmacy)		
Title of case study: Saving patients across England from hazardous prescribing through the implementation of a pharmacist led intervention, PINCER.		
Period when the underpinning research was undertaken: 2006 – 2014		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
Dr Matthew Boyd Professor Rachel Elliott Dr Sarah Rodgers	Associate Professor Professor of Medicines and Health Principal Research Fellow/ PINCER Programme Manager	2006 to current 2007 to 2016 1996 to current (June 2009 to December 2010 within UoA3)
Period when the claimed impact occurred: 2014 onwards		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

University of Nottingham researchers have developed a pharmacist-led IT-based intervention, PINCER (Pharmacist-led information technology intervention for medication errors), which has been implemented across England and is saving patients from medication harm. PINCER identifies hazardous prescribing and thus reduces 'at-risk' patients. 2,688 general practices (patient population 25,545,538) located within 104 (77%) Clinical Commissioning Groups (CCGs) in England have implemented PINCER. In total, 206,109 at-risk patients were identified with at least one prescribing safety indicator at baseline. Analysis of follow-up data from 1,060 practices showed a reduction in the absolute number of at-risk patients identified with at least one prescribing safety indicator of 13,387 patients (-14.4%). PINCER has been included in five national policy and guidance documents by NICE and the NHS.

2. Underpinning research

In 2017, the World Health Organisation (WHO) formally launched 'Medication Without Harm' as the theme for their third Global Patient Safety Challenge. This aims to reduce severe avoidable medication-related harm by 50% globally in the next five years by targeting health care provider's behaviour, systems and practices of medication, medicines, and the public. Prescribing errors in general practice are an expensive, preventable cause of safety incident, illness, hospitalisation and death.

Research, led by collaborators at Nottingham, found that prescribing errors were identified in 5% of prescription items, with 1 in 550 items containing a severe (potentially life threatening) error; this equates to approximately 2,000,000 serious prescribing errors in English general practices each year (*Br. J. Gen. Prac*. 10.3399/bjgp13X670679). Their further study showed hazardous prescribing in general practices to be a contributory cause of around 1 in 25 hospital admissions (*Br. J. Clin. Pharmacol.* 10.1111/j.1365-2125.2006.02698.x), and a recent Department of Health and Social Care (DHSC)-commissioned report into the prevalence and cost of medication errors estimated the annual hospital admission costs for primary care avoidable adverse drug events to be GBP83,700,000, resulting in 627 deaths in England each year (http://www.eepru.org.uk/article/prevalence-and-economic-burden-of-medication-errors-in-the-nhs-in-england/). Amelioration of some of the most important prescribing errors will, therefore, reduce medication-related hospital admissions and patient harm.

In 2006, informed by the Medical Research Council's (MRC) framework for complex interventions, researchers at the University of Nottingham (UoN) across the Schools of Pharmacy and Medicine led the design and implementation of a trial to determine the effectiveness, cost savings and acceptability of a complex pharmacist-led IT-based intervention in reducing hazardous prescribing to at-risk patients (PINCER).

The cluster-randomized control trial was conducted by a multidisciplinary team in the School of Pharmacy (Prof Rachel Elliott, Dr Matthew Boyd, Dr Sarah Rogers (2009 – 2010)) and School of Medicine (Prof Tony Avery, Dr Sarah Rogers), and Researchers at the University of Manchester and Edinburgh (R1). The study involved at-risk patients in 72 general practices who were being

prescribed drugs that are commonly and consistently associated with medication errors; specifically those involving non-selective non-steroidal anti-inflammatory drugs (NSAID), β blockers; long-term prescription of angiotensin converting enzyme (ACE) inhibitor or loop diuretics. The results of the trial, published in *The Lancet* in 2012, showed that the PINCER intervention is an effective method for reducing a range of clinically important and commonly made medication errors in primary care (R2). For example, at 6 months' follow-up, patients in the PINCER group were significantly less likely to have been prescribed an NSAID if they had a history of peptic ulcer without gastroprotection (OR: 0.58; 95% CI: 0.38–0.89), thereby reducing their risk of hospital admission with GI bleeding.

The economic analysis, carried out within the School of Pharmacy, determined the cost savings associated with the delivery of the PINCER intervention in the trial. Markov models for each of three primary and three secondary outcome medication-error measures of the PINCER trial were developed and analyzed using clinical event probability, treatment pathway, resource use, and costs extracted from literature. A composite probabilistic model combined patient-level error models with practice-level error rates and intervention costs from the trial. Cost-per-extra Quality Adjusted Life Year (QALY) and cost-effectiveness acceptability curves were generated from the perspective of NHS England, with a 5-year time horizon. Elliott determined that the PINCER intervention generated an overall reduction in cost of GBP2,679 per practice, and an increase in quality of life of patients (0.81 QALY per practice) (R3). At a ceiling 'willingness-to-pay' of GBP20,000/QALY, PINCER reaches 59% probability of being cost effective. PINCER had a 95% probability of being cost effective if the decision-maker's ceiling willingness-to-pay reached £75 per error avoided (at 6 months) or £85 per error avoided (at 12 months).

3. References to the research (research staff in **bold** from the School of Pharmacy, UoN)

R1. Avery, AJ., **Rodgers, S.,** Cantrill, JA**.,** Armstrong, S., **Elliott, RA**., Howard, R., Kendrick, D., Morris, C.J., Murray, S. A., Prescott, RJ., Cresswell, K. and Sheikh, A. Protocol for the PINCER trial: a cluster randomised trial comparing the effectiveness of a pharmacist-led IT-based intervention with simple feedback in reducing rates of clinically important errors in medicines management in general practices. *Trials* **10** (2009) 28 doi: 10.1186/1745-6215-10-28

R2. Avery A, Rodgers S, Cantrill J, Armstrong S, Cresswell K., Eden M, **Elliott RA**, Howard R, Kendrick D, Morris CJ, Prescott RJ, Swanwick G, Franklin M, Putman K, **Boyd MJ,** Sheikh A. Pharmacist-led information technology-enabled intervention for reducing medication errors: multi-centre cluster randomised controlled trial and cost-effectiveness analysis (PINCER Trial). *The Lancet* **379** (2012) 1310-1319

R3. **Elliott RA**, Putman KD, Franklin M, Annemans L, Verhaeghe N, Eden M, Hayre J, Rodgers S, Sheikh A, Avery AJ (on behalf of the PINCER Team). Cost-effectiveness of a pharmacist-led information technology intervention for reducing rates of clinically important errors in medicines management in general practices (PINCER). *PharmacoEconomics* **32** (2014) 573-590 doi: 10.1007/s40273-014-0148-8. (Epub 18 March 2014)

Grants:

R4. Rodgers S, Avery AJ, Silcock N, Bassi M, Bell B, Salema N, **Elliott R**, Ashcroft D, Sheikh A, Swanwick G, Chuter A. *Preparing for a Phase IV implementation trial using PINCER methodology aimed at reducing the incidence of serious hospital admissions.* NIHR Research Capability Funding to develop an NIHR Programme Grant for Applied Research, January 2014. Amount awarded GBP49,878

R5. Rodgers S, Avery AJ, **Elliott R,** Bell B, Franklin M. *Modelling the cost effectiveness of prescribing safety indicators to identify those that are likely to be most cost-effective for inclusion in a rollout of the PINCER trial intervention.* NIHR SPCR Round 7, June 2013. Amount awarded GBP29,973

Awards:

The team at the University of Nottingham was shortlisted from 800 teams across the NHS Midlands and East, and selected as regional winner in "*The Excellence in Primary Care Award*" category of the 2018 NHS70 Parliamentary Awards, for their work on PINCER.

4. Details of the impact

Researchers at the University of Nottingham have directly increased the safety of patients across England. The pharmacist-led IT-based intervention (PINCER), developed and tested by researchers at Nottingham, reduces clinically important medication errors in primary care, a long-standing global patient safety challenge. The clinical and economic evaluation led to PINCER being selected by the AHSN Network for national adoption and spread (https://www.ahsnnetwork.com/about-academic-health-science-networks/national-programmes-priorities). PINCER has been included in NICE Guidelines and implemented widely across NHS England.

Clinical impact of PINCER

As of 7 December 2020, 2,688 general practices located within 104 (77%) CCGs had uploaded baseline data to the online comparative analysis service, CHART Online, showing that 25,545,538 patient records had been searched to identify instances of potentially hazardous prescribing using 13 prescribing safety indicators. In total, 206,109 at-risk patients were identified of being at risk of at least one prescribing error at baseline giving an overall prevalence of 8.07 patients at risk of medication error per 1,000 registered patients prior to the PINCER intervention. Analysis of follow-up data from 1,060 practices showed a reduction in the absolute number of at-risk patients identified in at least one prescribing safety indicator of 13,387 patients (from 92,762 to 79,375 patients; -14.4%). Greatest reductions were seen for those indicators associated with GI bleed, which showed a decrease of 10,559 at-risk patients (from 40,720 to 30,161 patients; -25.9%) [A, B].

One of the key strengths of the national rollout of PINCER has been the ability for general practices, pharmacists and named individuals at CCGs to access comparative views of numbers of at-risk patients using an Online comparative analysis service, CHART, including time-trended analyses [B]. Over time, as more and more practices have been participating in the national rollout of PINCER and uploading their summative data, the facility has been providing a national picture of medication safety thus enabling localities to prioritise areas for improvement and evaluate the impact of the PINCER implementation. For example, the Clinical Lead for Medicines Optimization with Wessex AHSN stated *"… we successfully deployed PINCER in 236 practices, which is 94% of all of the practices in Wessex. This has given us a robust baseline measure of medication safety but more importantly, when practices implemented the PINCER intervention, we had 3,441 fewer patients at risk from clinically significant medication errors compared to baseline*." [C]

Upskilling the primary care pharmacy workforce

To date, at total of 2,032 individuals (1,505 primary care pharmacists, 153 primary care pharmacy technicians, 176 GPs, 48 practice managers and 150 CCG/other primary care staff) have been trained to deliver the PINCER intervention through a combination of eLearning tools, online resources, live webinars and face-to-face action learning set sessions [D].

Incorporation of PINCER into national Medicines Optimisation policy and guidance

Since 2015, PINCER has been incorporated into the NICE 'Medicines Optimisation Clinical Guideline' published 04 March 2015 [E]. This means that general practices throughout the country are encouraged to use the intervention. In 2017, the World Health Organisation identified 'Medication Without Harm' as the theme for their third Global Patient Safety Challenge which aims to reduce severe avoidable medication-related harm by 50% globally in the next 5 years. In response to this challenge, the NHS Business Services Authority produced a Medication Safety Dashboard drawing on the PINCER indicators for GI bleed and Acute Kidney Injury [F]. The system links prescribing data in primary care to hospital admissions to help the NHS monitor and prevent errors.

In February 2018, the Short Life Working Group of the DHSC published a report stating that "*In primary care settings, the use of interventions such as pharmacist-led information technology*

intervention (PINCER) should be employed." and that a "*key priority is the "roll-out of proven interventions in primary care such as PINCER*." [G]

In January 2019, NHS England published "Investment and evolution: A five-year framework for GP Contract Reform to implement the NHS Long Term Plan". Prescribing safety was a new quality improvement domain in the contract, with practices incentivised to demonstrate continuous quality improvement in relation to prescribing safety. The Framework stated (Section 3.16, page 22) "the nationally-backed rollout of the pharmacist-led information technology intervention for medical errors (PINCER or equivalent) by the AHSNs" as one of four key areas for Quality Improvement. PINCER provided a mechanism for practices to achieve this, as well as providing CCGs with a process for verifying GP practice achievement [H].

PINCER has also been identified as an evidence-based approach to reducing a range of medication errors as part of the mandatory QI project in the new GMS Contract Wales: QI Framework 2019-20, and discussions about the rollout of PINCER to general practices in Wales are ongoing [I]. In July 2019, the NHS Patient Safety Strategy highlighted PINCER as one of its Medicines Safety Improvement Programmes to support work to reduce prescribing error rates by 50%, improving safety and reducing costs. More recently, in September 2020, the Primary Care Network (PCN) Service Specifications highlighted PINCER as a tool to help clinicians to identify patients who would benefit most from receiving a Structured Medication Review (SMR) [J].

In summary, research from the University of Nottingham has led to a significant increase in the protection of patients across England from harmful prescribing errors.

5. Sources to corroborate the impact

A. PINCER Progress report URL: https://www.nottingham.ac.uk/primis/documents/pincer/pincer-progress-report-ext-exec-summary-july-2020.pdf (July 2020, also PDF).

B. CHART Online comparative analysis screenshots (07/12/20 PDF).

C. Corroborating statement from Clinical Lead for Medicines Optimization with Wessex AHSN (PDF).

D. PINCER train-the-trainer data (07/12/20, PDF).

E. National Institute for Health and Care Excellence. Medicines optimisation: the safe and effective use of medicines to enable the best possible outcomes. URL: https://www.nice.org.uk/guidance/ng5/resources/medicines-optimisation-the-safe-and-effective-use-of-medicines-to-enable-the-best-possible-outcomes-pdf-51041805253 (March 2015, also PDF).

F. NHS Business Services Authority (BSA) Medication Safety Indicators Specification – Information and Technology for Better Health Care (August 2019, PDF).

G. Department of Health and Social Care. The Report of the Short Life Working Group on reducing medication-related harm. URL: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/683430/short-life-working-group-report-on-medication-errors.pdf (February 2018, also PDF).

H. NHS England. Investment and evolution: A five-year framework for GP Contract Reform to implement the NHS Long Term Plan. URL: https://www.england.nhs.uk/wp-content/uploads/2019/01/gp-contract-2019.pdf (January 2019, also PDF).

I. Welsh Government. Quality Assurance and Improvement Framework Guidance for the GMS Contract Wales 2019/20. URL: https://gov.wales/sites/default/files/publications/2020-11/guidance-for-the-gms-contract-wales-2019-20.pdf (also PDF).

J. NHS England and NHS Improvement. Network Contract Direct Enhanced Service: Service Specifications. URL: https://www.england.nhs.uk/wp-content/uploads/2020/03/Network-Contract-DES-Specification-PCN-Requirements-and-Entitlements-2020-21-October-FINAL.pdf (September 2020, also PDF).